SCIENCE TEACHERS REFLECT ON THEIR INQUIRY-BASED PRACTICES:

Exploring the Perceived Benefits and Challenges of the BC Curriculum

by

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Abstract

This research explores inquiry-based teachers' perceptions of the benefits and challenges of the redesigned science curriculum implemented in British Columbia (BC) in 2016. A qualitative research methodology was used to gather data from six secondary science teachers identified as inquiry-based teachers. Participants identified the following benefits of the redesigned science curriculum: opportunities for relevant learning, increased student and teacher autonomy, enhanced student curiosity, and the inquiry-oriented framework of the new BC science curriculum. The participants' challenges included a lack of professional resources and support, as well as systemic barriers to inquiry-based teaching related to assessment and reporting, teacher mindset, and expectations for post-secondary. The practical implications that emerged from the findings call for further support for resources, professional development, and leadership at the school and district level to help implement the 2016 BC curriculum. These implications also highlight the systemic challenges within the current education system in BC. Several recommendations include resources that reflect the 2016 BC curriculum, reconsideration of the present frameworks for assessment and reporting in BC, and starting a critical conversation about the alignment of the current educational system in BC with the 2016 BC curriculum.

Keywords: inquiry-based learning, 2016 BC curriculum, secondary science teachers, British Columbia, inquiry-based teaching

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Dedication

I dedicate this study to all who are actively doing personal work to move towards an equitable society that invites diversity, inclusion, acceptance, and understanding for all.

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Introduction

In 2016, the British Columbia (BC) Ministry of Education introduced a new K-12 curriculum. The purpose of the redesigned science component of the new curriculum is to develop scientifically literate citizens who display care towards themselves and others and understand social, health, ethical, and environmental issues locally and globally (BC Curriculum, 2020c). The BC curriculum document states that through an appreciation of science, learners can recognize opportunities to apply their knowledge to their everyday lives and make more informed decisions.

Learners need to be provided opportunities that align with the goal of science education. In the 1950s and 1960s, the Space Race controlled school reform by making it a subject-centered curriculum that reflected mastery of subject matter through facts, trivia, and memorization of the content (Kazempour & Amirshokoohi, 2014; Sun et al., 2015). Researchers like Roehrig and Kruse (2005) suggest that teachers today need to create inquiry-based learning environments that enhance scientific literacy for all students. An inquiry-based focus ensures that students obtain scientific knowledge, skills, and habits of mind to be productive members of our society (Roehrig and Krause, 2005). In response to inquiry-based learning, the BC curriculum writers aimed to provide more personalized (less standardized) instruction, critical thinking skills, cross-curricular/interdisciplinary competencies, and inquiry-based learning (BC Curriculum, 2020b).

The 2016 BC science curriculum provides opportunities for learners to better understand the natural world around them. Science education encompasses traditional subjects, such as biology, chemistry, physics, earth and space sciences, and scientific laws and theories (BC Curriculum, 2014; Lederman et al., 2019). In response to John Dewey's ideas of learning through

active inquiry, an inquiry-based approach was advocated in British Columbia's redesigned curriculum (Sun et al., 2015). The redesigned science curriculum gives learners opportunities to develop skills, processes, attitudes, and scientific habits of mind to pursue their inquiries. The competencies included in the BC science curriculum include "questioning and predicting, planning and conducting, processing and analyzing data and information, and evaluating and communicating" (BC Curriculum, 2020b). These competencies mirror the scientific method that allows learners to use critical thinking, creative insight, and scientific knowledge to be scientifically literate citizens (Sun et al., 2015).

BC's redesigned curriculum is responsive to learning through active inquiry (Sun et al., 2015). Inquiry is "the mindset that students use to build their knowledge and understanding through an active, open-minded exploration of a meaningful question, problem, or issues" (BC Curriculum, 2020b). Teaching science through inquiry provides students with opportunities to question and investigate their inquiries in a ‘hands-on’ and ‘minds-on’ manner (Santau & Ritter, 2013). Rooney (2012) and Zion (2007) indicate that learning through inquiry allows learners to focus on the "why" and "how" and less on the "what" for more active involvement and to gain a better perception of what science is (Ramnarain and Hlatswayo, 2018, p. 1). These opportunities should allow students to think, justify, create, question, invent, and design to better understand themselves and the environment around them.

Researcher's Experiences and Views

I believe that learning is a process that allows individuals to form their skills, beliefs, and ideas to become productive members of society. A school curriculum reflecting society's values of being "personally responsible, participatory, and socially-just citizens" (Westheimer, 2020, p.

9) enables students to discover, engage, and transform their thinking and apply it in a community. The opportunity to engage with their learning allows students:

> To think about issues of fairness and equality of opportunity […] that make the critical engagement a priority and encourage students to become informed about a variety of complex social issues and look for ways to improve society. (Westheimer, 2020, p. 8)

As an educator, I value teaching social justice, equity, diversity, anti-racism, and inclusion through student agency. Engaging in inquiry practices allows "teaching for equity and thinking about students in a more equitable way" (Tang et al., 2017, p. 513). Through the process of inquiry, the learning "occurs more naturally across all learning domains (affective, cognitive, and social)" (Blessinger & Carfora, 2015, p. 14). The different types of knowledge are acquired through diverse learning activities through active participation and experience with complex, real-life problems (Blessinger & Carfora, 2015).

I want to focus on each child being successful with their journey of learning in my classroom. In addition, I aim to foster personalized and individualized learning opportunities where students can create their understanding based on their lived experiences. John Dewey discussed the importance of relating school to students and life (Kay & Greenhill, 2011). Dewey encouraged learning opportunities that "engage students with inquiry" (Friesen & Scott, 2013, p. 7), allowing students to formulate their understanding related to their experiences.

I am an early-career secondary science teacher. During my Teacher Education Program (TEP) in 2016, we learned about diverse science inquiry models that improve student learning, understanding, and engagement. We learned about the principles of connecting student learning to real-life and about allowing students to make meaningful connections reflected in the current BC curriculum (BC Curriculum, 2020c). I am comfortable with the understandings presented in

BC's 2016 curriculum for two reasons. Firstly, I learned this curriculum during my TEP, and secondly, it is the only curriculum I have used in my teaching career. There is also an emphasis on embodying a socially just view that transformed my understanding of teaching and education. Being in a racial and gender minority group, I understand the importance of providing diverse and equitable opportunities to our learners. To foster social issues and improve society, I teach through an inquiry-based approach based on the 2016 BC curriculum.

I have been at two schools with different cultures, philosophies, and practices among teachers. My experience includes teaching a year at a secondary school with a focus on more traditional instructional and assessment practices. The traditional practices included standardized testing, teacher-centered practices, and an emphasis on content rather than skills and competencies. I have also spent three years at a secondary school where inquiry-based learning, student-centered approaches, and competency-based learning were encouraged and supported by teachers and administrators. The inquiry-based school reflects the work of Kay and Greenhill (2011), who believe that schools must focus on developing students' understanding of 21st-century skills. These skills allow students to learn from and work collaboratively with individuals from diverse cultures, religions, lifestyles; understand the subject matter beyond the classroom; and apply their learning within community or global contexts. At this school, the staff focuses on knowing as a *process* and not a *product*. Educators provide learning that allows students to "adapt appropriately and rapidly enough and to match the changing demands of the society in which we live" (Mackay and Bertani, 2016, p. 70).

Purpose of the Research Study

The purpose of this study is to explore the question, "What benefits and challenges, presented in the 2016 BC science curriculum, are perceived by secondary science teachers

experienced in science inquiry?" The question emerged upon reflection of my experience teaching at two very different schools. I noticed that my colleagues, the students, and administrators had different approaches to the 2016 BC curriculum. These observations raised a few questions: *Why are some teachers implementing inquiry-based practices and others not? How do teachers understand inquiry-based teaching? How does the 2016 BC curriculum support teachers with their inquiry-based approach? How does the 2016 BC curriculum hinder teachers' inquiry-based practice?*

Significance of Study

This study provides an opportunity for secondary science educators to discuss the benefits and challenges of the redesigned provincial curriculum from the unique perspective of their inquiry-based teaching practices and mindsets. It allows educators in the field to voice their concerns and highlight the strengths of the curriculum. Minimal research has been conducted on the impact of the 2016 curriculum implemented in BC (BCTF, 2016). By understanding educators' experiences with inquiry-based teaching and the 2016 curriculum, this study will provide further insights into better supporting educators with their inquiry-based practices and ultimately creating better learning opportunities for secondary students.

Literature Review

There are different interpretations of what inquiry is and how educators experience implementing inquiry into their practice. This literature review defines inquiry-based learning, presents an overview of teaching science as inquiry, and explores science teachers' perceptions regarding inquiry-based learning. The review then presents inquiry-based teaching from the perspective of BC's 2016 curriculum and BC teachers' perceptions of the redesigned curriculum. Lastly, the literature review will provide insights into teacher professional learning and implementation approaches to assist with inquiry-based classroom practices.

Inquiry-Based Learning

Inquiry-based learning has been defined in a variety of ways by different scholars. The two definitions provided in this section are based on Blessinger and Carfora, and Buchanan et al. Blessinger and Carfora's (2015) definition of inquiry-based learning is:

> A cluster of teaching and learning strategies where students inquire into the nature of a problem(s) or question(s). The problem or question scenario thus serves as a mechanism and catalyst to engage actively and deeply in the learning process. This approach is constructivist in nature because it allows the student to take greater ownership of her/his learning by allowing them a means by which to construct their own knowledge rather than just having that knowledge merely spoon-fed to them by others. (p. 5)

Within Blessigner and Carfora's model, one of the main goals of inquiry-based learning is to "move the learner from a passive state to become a more active participant in the learning process" (p. 6). Inquiry-based learning facilitates active engagement from the learners because they can formulate meaningful questions based on their passions and interests. The teacher is a guide in the learning process, assisting students in identifying their focus areas.

Buchanan et al. (2016) describe inquiry-based learning as a learning model grounded in the constructivist learning theory that focuses on "learning through the inquiry process or learning by doing" (p. 26). Additionally, Buchanan et al. state that inquiry-based learning has some or all of the following components: 1) a driving question, 2) authentic, situated inquiry, 3) learner ownership of the problem, 4) teacher-support, not teacher-direction, and 5) artifact creation (p. 27). Through inquiry-based learning, students have greater autonomy that helps them "develop knowledge and process skills as well as self-confidence, as they work and learn through questioning and problem-solving" (p. 22). The inquiry-based learning process provides students with the opportunity to experiment, fail, research, revise thinking, and try, which "engages in creative and innovative practices" (p. 22).

These two definitions of inquiry-based learning suggest that learning through inquiry allows the students to engage with their learning through questioning and active learning.

Teaching Science as Inquiry

Jean Piaget and Lev Vygotsky, pioneers of early childhood development and learning, inspired new approaches to teaching science through their constructivist and sociocultural theories. These theories state that children build their understanding of ideas in science through play and exploration (Isik-Ercan, 2020). The National Research Council highlighted in DiBiase and McDonald's (2015) research refers to inquiry as studying the natural world by developing questions and providing explanations based on the evidence collected. Inquiry-based learning allows students to develop knowledge and an understanding of scientific concepts by learning the process of science.

Learning through inquiry supports the goals of science education by developing what Abd-El-Khalick (2013) refers to as the Nature of Science (NOS) insights. NOS helps with the

understanding that science is constantly changing, and that science extends beyond the scientific method (Abd-El-Khalick, 2013). NOS encompasses an interdisciplinary approach to understanding science through “history, philosophy, psychology, and sociology of science” (Abd-El-Khalick, 2013, p. 2097). Abd-El-Khalick (2013) emphasizes that NOS understandings develop through inquiry teaching, leading to more engagement from students. Scientific inquiry and NOS are related by teaching students to "do scientific inquiry," which involves the teachers engaging the students in the "practices of science" (Capps & Crawford, 2012, p. 501). These practices include various activities and processes that "answer questions and develop explanations and models using logic and critical thinking" (Capps & Crawford, 2012, p. 501). Teaching science through inquiry provides students with opportunities to question and investigate their own inquires in a ‘hands-on’ and ‘minds-on’ manner (Santau & Ritter, 2013). Inquiry allows learners to focus on the 'why' and 'how' and less on the 'what' for more active involvement to better perceive what science is (Ramnarain & Hlatswayo, 2018). Teaching science through inquiry means teachers must possess a complex understanding of science concepts, the ability to make connections between various concepts, and apply their knowledge to real-world situations (DiBiase & McDonald, 2015; Santau & Ritter, 2013).

Summerlee (2018) emphasizes teaching students the skills to evaluate and verify information, encouraging them to be diverse thinkers, to be socially inclusive, and to work collaboratively. Education is impactful where social justice is the element of the learning process. Inquiry-based learning allows the opportunity to explore different cultures, backgrounds, and ways of thinking to create a more inclusive setting. Inquiry allows "diverse opinions and ways of thinking, learning what types of information are required to understand an issue, and where to find reliable information to support or refute ideas from multiple

perspectives" (Summerlee, 2018, p. 407). Inquiry-based learning looks beyond the content to incorporate multiple perspectives and ways of thinking. Within an inquiry-based science framework, there is no one right answer, and at times, a correct answer does not exist.

An inquiry-based learning environment in the science classroom requires a shift from the traditional teacher-centered approach to a learner-centered approach. Traditionally, the teacher provides the knowledge, often by speaking or using a textbook with pre-determined information. The transition from teacher to learner-centered practices involves shifting the role of the teacher away from being the 'sage-on-the-stage' to the teacher as "motivator, diagnostician, guide, innovator, experimenter, researcher, modeller, mentor, collaborator, and learner" (Ramnarain & Hlatswayo, 2018, p. 2). A teacher should balance these roles as they are implementing inquiry-based learning. In addition, Abd-El-Khalick's (2013) research recommends that teachers foster an inquiry learning environment by providing "planned reflective prompts" (p. 2094) to develop more vital inquiry skills in science. Although there is a growing consensus on the value of inquiry-based learning and teaching, research suggests that the "implementation of such a pedagogical practice continues to be a challenge for many teachers" (Ramnarain & Hlatswayo, 2018, p. 2). Challenges to teachers' implementation of inquiry-based learning in science classrooms include a lack of previous experiences with inquiry-based pedagogies as well as a lack of support, training, time; and the content presented in the science curriculum.

Perceptions of Science Teachers Regarding Inquiry-Based Learning

Many factors influence science teachers' perceptions of inquiry-based learning models. Tsai (2002) claims that teachers' beliefs about "how science is developed may be potentially related to their beliefs about how to teach science and how students learn science" (p. 771). Teachers' beliefs influence their practice in the classroom, which impacts students learning.

Similarly, Ramnarain and Hlatswayo's (2018) research suggests that if the teacher's core beliefs do not align with inquiry practices, it hinders their pedagogical strategy. A teacher's value system plays a vital role in their teaching practice. When teachers understand the purpose of education, it directly impacts their likelihood to implement inquiry-based instruction (Letina, 2019; Ramnarain & Hlatswayo, 2018). Cultural values, personal beliefs, and religion also impact understanding scientific concepts, ultimately affecting the implementation of inquiry into a science class (Mansour, 2015). The following sections will discuss the additional factors that influence a teachers' perception of teaching through inquiry.

Experiences. A possible contributing factor to implementing inquiry-based learning into the classroom is that teachers are less likely to implement it into their practice if they have never experienced it before or have had a negative experience (Letina, 2019; McDonald, 2017). Letina (2019) states that a factor contributing to the low frequency of inquiry-based teaching is teachers' lack of experience with inquiry-based instruction during their teacher education. The lack of practical implementation and formal education about inquiry impacts a teachers' confidence to implement inquiry into their practice (Kazempour & Amirshokoohi, 2014; Letina, 2019). In many instances, teachers read educational documents that describe inquiry-based learning and attend lectures on scientific inquiry; however, they do not get the opportunity to implement it into their practice during their initial teacher training (Letina, 2019). The gap between theory and practice highlights a concern in teacher education programs. On the contrary, Tsai (2002) highlights that teachers' limited teaching experience "might help them easily accept innovative thoughts of instruction" (p. 779). In the beginning years of teaching, teachers are still forming their teaching style and practice; therefore, early career teachers could be more inclined to implement inquiry-based learning.

If a teacher's teaching experiences do not align with the objectives of inquiry-based teaching, this can lead to a negative perception toward that type of teaching (Letina, 2019). Kazempour and Amirshokoohi (2014) also state that teachers prior learning experiences shape their beliefs and perceptions about inquiry-based learning. Often teachers have had few opportunities to "develop an understanding of the nature of scientific inquiry" (Kazempour and Amirshokoohi, 2014, p. 856) if they were in a traditional setting.

Support/Time/Training. A common teacher-identified obstacle identified is inadequate administrative support (DiBiase & McDonald, 2015; Fang, 2019; Letina, 2019). Examples include the lack of resources and insufficient training in pedagogy and methodological skills to implement inquiry-based learning (Kazempour & Amirshokoohi, 2014; Letina, 2019). Santau and Ritter (2013) argue that most administrators are supportive; however, they cannot provide additional time for teachers required to teach effectively. Most teachers state that more time with planning is needed, and other teachers feel the pressure of time constraints, either with the length of classes or the amount of curriculum to be covered (Ramnarain & Hlatswayo, 2018). Letina (2019) states that some science teachers feel traditional teaching is less time-consuming than inquiry-based instruction. Teachers with different pedagogical perspectives need opportunities to "critically discuss and reflect" (Tsai, 2002, p. 780), resulting in teachers changing their beliefs on teaching and learning.

Content. Another challenge identified by teachers is the content in the science curriculums. Fang (2019) explains that although implementing inquiry-based learning in science can be challenging, the subject's content plays a key role. Fang's research found that teachers are more likely to teach through inquiry in biology than in a physics class. A common tendency for teachers is to approach physics from the "top-down and to teach by [lecturing]" (National

Research Council, 2000, p. 93). In biology, teachers allow students to be autonomous to inquire about their questions (Fang, 2019).

To successfully implement inquiry-based instruction, teachers need to possess a strong understanding of scientific concepts (Letina, 2019). Teachers are challenged because many teachers have not had the opportunity to develop their "pedagogical content knowledge (PCK) to teach science" (Santau & Ritter, 2013, p. 257). PCK is the knowledge of analogies and strategies useful for teaching topics in science (Santau & Ritter, 2013). Many teachers believe that they require extensive background knowledge about the subject matter to effectively implement inquiry (DiBiase & McDonald, 2015). On the contrary, Mansour (2015) states that if there is a mutual learning environment (between the teacher and student) using inquiry as a learning tool, extensive background knowledge is not required.

Inquiry-Based Learning in BC's Redesigned Curriculum

In 2010, the Ministry of Education began a discussion to transform education in BC to better meet all learners' needs (Ministry of Education, 2012). The focus was to create a flexible curriculum that allowed for teacher and student autonomy by removing the "barriers that limit teachers' ability to innovate and personalize learning based on students' needs and the community context" (Ministry of Education, 2012, p. 2). Although there were previous attempts to implement inquiry in BC, the Ministry of Education wanted to transform education to "empower innovation throughout the province" (Ministry of Education, 2012, p. 2). To foster the innovative environment, the priorities for the curriculum change included strategies that would focus on the educated citizen, learning standards, required learning, competencies, flexible instructional design, implementation support, vulnerable learners, management, First Peoples Principles of Learning, and equity (Ministry of Education, 2012).

BC's Science Curriculum. Science and scientific literacy are critical components for understanding the changing world. The BC Curriculum (2020b) states that to succeed, the students need to be presented with:

> The ability to think critically, solve problems, and make ethical decisions; to communicate their questions, express opinions, and challenge ideas in a scientifically literate way; and to exercise awareness of their role as ecologically literate citizens, engaged and competent in meeting the responsibilities of caring for living things and the planet. (para 1)

The main features of the science curriculum focus on inquiry and conceptual learning. The teachers allow students to ask questions, consider multiple and diverse perspectives, recognize and form their beliefs and opinions, work in a collaborative environment, and make informed inferences that lead to responsible choices.

The science curriculum allows for flexible teaching and learning. There is autonomy in how educators choose to combine big ideas, curricular competencies, and content to create learning experiences for students. The big ideas in the science curriculum "tell the story of science through principles and key concepts, emphasizing the 'understanding' of science" (BC Curriculum, 2020b). The curricular competencies emphasize the "doing" of science. The competencies reflect the scientific method and are "questioning and predicting, planning and conducting, processing and analyzing data and information, evaluating, applying and innovation, and communicating" (BC Curriculum, 2020a). The content emphasizes the "knowing" of science. The science curriculum is rooted in inquiry to allow the students to develop a deeper understanding of scientific concepts.

Teacher Perception of the BC Curriculum

Although there is limited research on the redesigned 2016 BC curriculum, there is ongoing research conducted by the British Columbia Teachers Federation (BCTF) that explores the strengths and challenges experienced by K-12 teachers with respect to the new curriculum. The 2016 feedback report completed by the BCTF revealed that educators in the province were generally positive about the inquiry and cross-curricular approaches that support the curriculum (BCTF, 2016). Another piece of positive feedback focused on flexibility in the curriculum to allow for adapting "subjects to meet the needs of particular groups of students, and value opportunities for collaboration with other teachers" (BCTF, 2016, p. 3). However, the BCTF research identified several areas of concern regarding the curriculum, which focused on resources, curricular content, implementation time frame, provincial assessment, reporting, and educational change.

Based on the research of the BCTF, many teachers expressed that they required additional educational resources to support the curriculum change and funding resources. The teachers mentioned that they use their own money and time to make changes in their practice (BCTF, 2016). Teachers felt that the Ministry of Education should fund these resources in order for teachers to implement the curriculum successfully (BCTF, 2016). Gacoin (2019) found that teachers are still concerned with the lack of resources to support their practice.

With the curriculum change, some of the curricular content was shuffled into different grade levels. Many teachers expressed that the new content presented for some specific grades is inappropriate because it can be too challenging for the students (BCTF, 2016). Teachers also felt a tension between the "breadth and depth in curricular content" (BCTF, 2016, p. 5). Some

teachers preferred the flexibility of the content to decide how and what they would like to teach, while others expressed that the content area is too vague in the new curriculum (BCTF, 2016).

There is also tension between the stated vision and the reality of the redesigned curriculum (BCTF, 2016). Many teachers felt that the Ministry of Education in BC should have prioritized professional development, consultation with teachers, and frameworks for collaboration before implementing the curriculum throughout the province (BCTF, 2016). Teachers reported feeling overwhelmed with the lack of preparation and said they needed more transition time (BCTF, 2016).

In addition, teachers are concerned about student assessment (BCTF, 2016). Assessment is an ongoing challenge because of "the lack of alignment between the redesigned curriculum and assessment and reporting systems" (Gacoin, 2019, p. 6). At the primary and intermediate level, "only 39% of teachers feel that assessment and reporting are aligned with the redesigned curriculum" (Gacoin, 2019, p. 6). At the secondary level, "only 32% of teachers feel that assessment and reporting are aligned with the redesigned curriculum" (Gacoin, 2019, p. 6). These statistics highlight the disconnect between the curriculum vision and the reality of what teachers are experiencing with their practice. Teachers felt that there is still ambiguity and inconsistency with the graduation requirements (BCTF, 2016).

While the curriculum promotes skill-based learning, teachers do not understand how to assess the competencies. For example, teachers struggle to "assess empathy" (BCTF, 2016, p. 8). In addition, teachers question how to assess the core competencies and "how they would be translating co-operative learning into a mark" (BCTF, 2016, p. 8). More teacher autonomy for using different assessment tools and better alignment with the current curriculum could result in authentic learning (BCTF, 2016).

Many teachers expressed a lack of transparency for the change in curriculum. They are implementing the 2016 BC curriculum as a means of educational reform to support the 21st-century learners and the changing society through a competency-driven curriculum (BCTF, 2016). However, some teachers are still trying to understand how to create "personalization" of learning in a "public social institution" (BCTF, 2016, p. 9). Professional learning and understanding areas for systemic improvement can be responsive to the changes in educational systems.

Implementation Approaches to Inquiry Teaching

Teacher professional learning allows teachers to understand the new challenges present in education systems (Timperley & Alton-Lee, 2008). Avalos (2011) describes teacher professional learning to be a "complex process, which requires cognitive and emotional involvement" (p.10) to focus on student learning by improving or changing their teaching practice. Governments worldwide are looking for education systems to be "more responsive to the diversity of their learners and to meet the higher expectations and future focus required by knowledge societies" (Timperley & Alton-Lee, 2008, p. 335). There is a sense of urgency to be responsive to all students to understand the learners' moral, economic, social, and equitable factors. Teachers need to know how their teaching practice affects students' learning (Darling-Hammond, 1998). When teachers are aware that their new professional learning and practice positively impact their students, they feel more effective (Timperley, 2008).

Timperley (2008) provides suggestions for systemic improvement and sustainable development in education. Teachers need to learn "sophisticated assessment skills" (p. 13) to ensure that they are providing a variety of ways to assess students' progress. Assessment needs to "go beyond standardized testing" (p. 13) to respond to diverse students' learning needs. An

alternative method to standardized testing is interviews with students. Another way to improve systems in education is to designate leaders to facilitate professional learning and development for educators. Professional development opportunities that are closely related to the school community are more effective. In addition, leaders' roles include:

> Ensuring that teachers understand new information, engaging dissonance constructively when existing assumptions are challenges, ensuring that teachers have productive opportunities to learn, and providing incentives for teachers to continue to enact the new learning in practice. (Timperley, 2008, p. 23)

Leaders need to understand their complex role to support teacher professional learning and development, ultimately improving student learning.

Gaps in the Literature

There has been extensive research conducted on inquiry-based learning, teaching science through inquiry, understanding teachers' perceptions about inquiry-based teaching, inquiry-based learning in BC's 2016 curriculum, and perceptions of teachers on the BC curriculum. While the BCTF has been conducting ongoing research on teachers' perceptions of the new curriculum (BCTF, 2016), they have not explicitly focused on teachers' perceptions of the secondary science curriculum. The current study contributes to the existing literature on teachers' perceptions of inquiry-based learning by examining the perceptions of secondary science teachers using the 2016 BC curriculum. The central inquiry question for the research is: "What benefits and challenges, presented in the 2016 BC science curriculum, are perceived by secondary science teachers experienced in science inquiry?"

Methodology

Through this research, I sought to explore the benefits and challenges presented by the 2016 BC science curriculum from secondary science teachers experienced in science inquiry. In terms of ontology, I was interested in the participants' perceptions of their own experiences with the new curriculum, specifically as it influenced their teaching of science through inquiry. Given that the research goal was to seek an "understanding of the world" in which the study participants "live and work" (Creswell & Poth, 2018, p. 24), I worked from a social constructivist paradigm. I gathered knowledge from the individual participants through a qualitative research methodology (Anderson & Arsenault, 2005).

Since I was interested in investigating a specific phenomenon, notably the experience of teaching science inquiry using the 2016 BC curriculum, my research was best suited to a phenomenological method (Creswell & Poth, 2018). I aimed to understand the participants' individual experiences through interviews to capture "the essence of the experience for all individuals" (Creswell & Poth, 2018, p. 75). The interviews included open-ended questions (see Appendix A) to allow the participants to narrate their interpretations of the questions based on their lived experiences. The data collected allowed me to understand what the participants experienced and how they experienced it (Creswell & Poth, 2018, p. 77).

Bracketing

Through a phenomenological reflection, I bracketed myself out of the study by addressing my own experiences, biases, and assumptions (Creswell & Poth, 2018). My assumptions could impact the narrative; therefore, it was essential to understand my values and biases and position myself within the research (Creswell & Poth, 2018). I initially went into this research believing the curriculum itself would be a challenge for the participants. This

assumption was informed by my personal experiences and conversations with administrators, students, and teachers; my journey as an educator informed by my Teacher Education Program (TEP); personal and professional experiences in the classroom; the Master of Education program; and various professional development opportunities. My values also influence my research and perspective. I am grounded in my values as they drive my personal and professional life. I value collaboration, life-long learning, diverse approaches to learning and teaching, individualized learning, inclusion, equity, and a socially just practice. To minimize the influence of my biases, assumptions, and experiences, I needed to be aware of them concerning teaching science inquiry and the 2016 BC science curriculum.

By acknowledging and addressing my biases, assumptions, and experiences, I was able to set them aside to investigate the phenomenon and focus on the participants' experiences. This approach allowed me to have a fresh perspective. Van Manen (1990, 2014), as cited in Creswell & Poth, 2018), states that it can be difficult to bracket personal experiences "because interpretations of the data always incorporate the assumptions" (p. 81); therefore, it was essential to be mindful of this possibility. I kept a bracketing journal that included my thoughts, questions, initial reactions, biases, assumptions, and personal experiences related to the phenomenon and during the interviews.

Context of the Study

This research took place within the context of the BC public school system within one school district located in the Fraser Valley. The participants were secondary science teachers from four different schools who self-identify as inquiry-based teachers. Participants were teachers of anatomy and physiology, earth science, environmental science, life sciences, physics, and science for citizens. In addition, there was one participant who taught Advanced Placement

(AP) science classes. There are different types of inquiry-based practices in these secondary schools, including approaches outlined in the BC Curriculum (2020), such as project-based learning, case method, problem-based learning, scientific inquiry, and design-based learning.

Global Pandemic

This research study took place amid the (COVID-19) global pandemic, which significantly influenced student learning, teaching, and the daily operations of schools. Students and staff members were required to wear masks in common areas during the study, practice physical distancing, and practice hand hygiene. In some cases, physical barriers between the staff members and students affected how they interacted. Secondary schools had new timetables in which the teachers had to adjust their coursework into a condensed 10-week period (quarter system) instead of 20 weeks (semester system) with staggered start and end times. This revised schedule meant that each class was three hours long instead of 80 minutes. In addition, teachers and students were adjusting to teaching and learning in a blended-learning environment, which required that teachers balance both online and in-person instruction each day. With COVID-19, there were stricter rules regarding sicknesses. If students or staff experienced any symptoms, they were required to stay home from school, which resulted in an increased number of absentees across the district. Some students opted for homeschooling and online and distributed learning to accommodate different levels of safety and protection. Collaboration amongst teachers shifted to an online space, and all meetings were virtual.

Participants

I obtained permission from the Human Research Ethics Board at the University of the Fraser Valley (UFV) before conducting the research. I also received approval from the school district's superintendent to research in schools and approach participants within the district. I

used purposeful sampling based on recommendations from the district's curriculum department. I contacted the curriculum department by email to ask for recommendations for participants that met the following sampling criteria for this study:

a) All participants were secondary science teachers within the school district;
b) All participants had at least five years of experience teaching with inquiry (any of the approaches outlined above); and
c) All participants had experience teaching with the 2016 BC science curriculum.

I emailed individuals whom the curriculum department contact had recommended asking for their interest in participating in the research. I emailed 12 individuals in early to mid-January 2021. Polkinghorne (1989, as cited in Creswell & Poth, 2018) states that researchers should interview a minimum of five individuals that have experienced the phenomenon, so my goal was to interview at least five participants. In the end, six teachers consented to participate in the study. In January 2021, I sent a letter of informed consent to the individuals who volunteered to be part of the research that outlined the purpose, procedures for the study, potential benefits and risks to participants, the confidentiality of the participants, and their time commitments.

I reminded participants that their participation was voluntary. I respected the participants' privacy and different cultural, religious, gender, and other differences. I ensured their privacy by removing identifiable information and making general statements about the participants. They were anonymized using a pseudonym and pronoun of their choice (Creswell & Poth, 2018).

Data Tools

Interviews were conducted online using the platform Zoom due to COVID-19. The interviews took place in January 2021. The participants met with me for their interview for

approximately 20-40 minutes. The participants were asked seven questions in their semi-structured interview to understand their perceptions of the phenomenon under investigation (See Appendix A). The questions were open-ended to allow the participants to provide information from their perspective and share their understanding of the situation. During the interviews, I recorded my initial thoughts, first impressions, assumptions, biases, and questions in a double-response journal to bracket myself and minimize the risk of my assumptions and biases appearing in the data analysis (Miles et al., 2014). During the interview, I avoided leading questions based on my perceptions.

Data Analysis

I used Otter.ai to transcribe the audio recording of the interviews. I cross-checked the audio with the transcripts to ensure accuracy. Based on the audio, I fixed grammatical errors to make it more readable when analyzing the data. To comply with the ethics of qualitative research and the security of the participants, I deleted the transcript off the Otter.ai site within 24 hours following the interview (Creswell & Poth, 2018). I showed the participants a copy of the transcript. Through the member check, the participants could edit, add, and/or delete anything on the transcript to ensure accuracy and approval before analyzing the data (Miles et al., 2014). Participants indicated their acceptance of the transcript in February 2021. I anonymized the transcripts after the participants' approval. All raw data (non-anonymized information) was then deleted or shredded.

I analyzed the transcripts one at a time. I worked by hand to interpret the data and made "preliminary notations directly on the data documents by highlighting [and] noting" (Saldana, 2011, p. 95). When I initially reviewed the data, I included first impressions, reminders to follow up with the participants about surprises, and connections with the data (Saldana, 2011). I cross-

referenced these notes with assumptions, biases, initial thoughts, and impressions and questions from the double-response journal from the interview. By comparing the two different assumptions and biases, I was more aware of what they were as I analyzed the data.

1st Level Coding

I used descriptive coding for the analyses of the data. Descriptive coding is used to understand the summary of the topic and provide a general idea (Saldana, 2011). For this step, I read through the data and highlighted significant statements, including sentences or quotes that showcased how the participants understood the phenomenon (Creswell & Poth, 2018). I also made side notes on the margins to indicate the summary description. After all the transcripts were read through and coded, I entered the selected quotes, sentences, or phrases into an Excel document.

2nd Level Coding

I organized the statements into categories with a "similar pattern of characteristics" (Miles et al., 2014, p. 278) to capture the bigger picture and the essence of the phenomena. The descriptions summarized both 'what' the individuals experienced and 'how' they experienced it (Creswell & Poth, 2018, p. 77). The categories helped me understand the main ideas that the participants expressed.

Managing Bias

The participants were selected based on an expert recommendation, reducing the risk of bias (Miles et al., 2014). I also managed my own bias by showing the data and analyses (codes, categories, and themes) to an expert reviewer (my supervisor) (Miles et al., 2014). In addition, the participants also had an opportunity to provide feedback through a member check (Miles et

al., 2014). When there were surprises present in the data, I followed up with a phone call to clarify the responses. In this case, there were two participants (William and Lola).

Strength of Study

With the triple crisis approach, I focused on the representation, legitimization, and praxis aspects of the study (Denzin & Lincoln, 2005). The triple crisis approach helps with reducing the qualitative researcher's biases in the study (Denzin & Lincoln, 2005). For representation, I concentrated on providing thick descriptions of the participants. The descriptions included the information that the participants felt comfortable sharing when describing themselves in the interviews. This research focused on participants who self-identify as inquiry-based teachers' perceptions of the new science curriculum. In addition, the participants provided explanations of how they understood and defined inquiry and inquiry-based learning. For legitimizing the study, I used direct quotes from the participants to highlight the participants' experiences as they perceived them. I also had an expert reviewer during the analyses and synthesis of the data, who assisted with reducing the influence of my personal bias. To support praxis, this research focused on participant experiences. They described the benefits and challenges of their inquiry-based practice. The participants were asked to give feedback on the current curriculum in terms of their inquiry-based practices and make suggestions for the new curriculum.

Findings

The central inquiry question for this study was: "What benefits and challenges, presented in the 2016 BC science curriculum, are perceived by secondary science teachers experienced in science inquiry?" The following findings reflect my analysis of the interview transcripts from the participants in this research study. The first part of this discussion introduces the participants and

presents their individual understandings of inquiry-based learning and practice, which they shared during the interviews. The data from the interviews are then presented in two broad categories representing the benefits and challenges of the redesigned BC science curriculum. Within each category, sub-themes that emerged from the analysis of the participants' responses are discussed.

Introducing the Participants

The participants provided general descriptions to introduce themselves. "William" described himself as an "adventurous learner who is curious about the world he lives in." William is a physics educator who has taught at various schools within the Fraser Valley. "Lola" described herself as a "lifelong learner, an innovator, with an infinite mindset," and cares about people and learning. Lola is a senior science educator who has taught at various schools in the Fraser Valley. "Jaspreet" described herself as "friendly, middle-aged, married, and an empty nester." Jaspreet is a junior science educator who is currently in a new non-enrolling role. "James" described himself as a "normal geek" who has loved science since grade 9. James is a junior science and chemistry educator and has taught at various schools in the district. "Cruz" described himself as loving the journey of teaching for the past 25 years and is "still learning like crazy." Cruz teaches junior sciences and has taught n at various schools in the district. "Gary" described himself as enjoying teaching in the classroom and has been teaching for 28 years. Gary has taught multiple courses, but now he teaches the senior AP courses. Gary finds value in having taught at various schools because "you get new ideas, new ways to do things, [and] to collaborate with different people."

Participants' Understanding of Inquiry-based Learning and Teaching

The participants' answers to the first two questions from the interview provide essential insights into their understanding of inquiry-based learning and inquiry-based practice. The first two questions were: "What does inquiry-based learning mean to you?" and "What does it mean to be an inquiry-based science teacher?" In answering these questions, the participants defined what inquiry-based learning meant to them and how their practice supports inquiry-based learning in science. The participants also shared their journey with inquiry-based teaching within the context of the 2016 BC science curriculum.

Lola described inquiry-based learning as being able to "discover things in a different way, and there's no structure to it [and] that you are just discovering." To Lola, it is about "being inquisitive, asking questions," and then being able to discover them independently or through collaborative approaches. To be an inquiry-based teacher, Lola believes that the educator "needs to release control" to allow the students to be autonomous and making meaning out of their learning. In the classroom, this looks like being "free of textbooks" and other traditional teaching methods. Lola expressed that her dream for education is similar to "when they were young, like being in kindergarten [which is] all inquiry learning"; however, her concern is that through "the whole school process, the students lose [being inquisitive]."

William said that "inquiry-based learning is simply discovering." He believes that it is "how you're wired to learn from the very beginning of your life," and through this natural curiosity, "you explore and try to understand the world, and that leads to better understanding." To foster this learning for the students, William "permits individual pathways to learn" as his primary design practice. William gives students autonomy and agency in their learning to "follow threads of curiosity" to create their meaning. Like Lola, William's dream is to "have high-school like kindergarten" to foster a proper inquiry-based learning environment. However,

William expressed that this is limited in today's educational system "by what the teacher wants to tell you that day and what they think is interesting and [the student] might not."

Jaspreet expressed her understanding of inquiry-based learning as the educator engaging students in "a complex real-life, meaningful question that persists or leads to new inquiries that allow students to pursue content and learning in the context of the overall inquiry." Jaspreet provides the opportunity for students to have a cross-curricular approach through inquiry-based learning. A part of Jaspreet's practice is that she is "looking at [the students] abilities in each of the curricular competencies" instead of relying "on a recall of vocab or facts or demonstration of some mathematical skill or concept manipulation." Jaspreet expressed that it would be ideal for making learning more relevant is measuring student's learning through an authentic "summative piece that [is] fairly complex and comprehensive.'

Gary explained inquiry-based learning as a "continuum or a range" where the "students develop the question, something that's related to the community." Gary described the continuum as project-based learning for three to four months or an inquiry lab that lasts one to three days. In terms of his inquiry-based practice, Gary poses "a problem and then using the scientific method, [the students] have to demonstrate that [by coming] up with a hypothesis." Gary states that students should be able to develop "a question that can't be Google searched [… and] should be related to the community around them."

James interpreted inquiry-based learning as "not focusing on the content." James further explained his definition of inquiry as students "not focusing on the facts that are being memorized." Instead, students are "focusing on the process of learning." James fosters an inquiry-based learning approach for the students by allowing them to "go learn some stuff, ask some questions, and find [their own] answers." He stated that he has never been the teacher who

relies on the textbook for questions and answers. He focuses his practice on allowing the students to be "curious and inquire" based on their interests.

Cruz explained inquiry-based learning as "giving the students space or the chance to go and explore what they would like to learn within the context that we are in." Cruz was inspired by the book "Just Make One Change," which focuses on teaching students to ask their own questions. Through that book, he developed an inquiry-based practice that would allow his students to “develop their questions, then research that topic within the context of [the] class, and then allow them to have a chance to present what they learned and then reflect on that process that they went through." At this point in his teaching career, Cruz believes that inquiry is a tool in his “teaching toolkit."

In summary, the participants expressed different approaches to inquiry ranging from teacher-led to student-driven inquiry. Some participants said they approach inquiry by creating the guiding question, whereas other participants allow the students to explore their learning paths. All the participants believe that inquiry-based learning fosters curiosity and relevant learning, further explored in the following section.

Benefits

The participants highlighted the benefits of the new science curriculum throughout their interviews. The four emergent sub-categories from the participants' responses were relevant learning, increased autonomy, enhancing curiosity, and the inquiry-orientated framework of the BC science curriculum. Table 1 below shows the frequencies of how many times the participant mentioned the codes for the sub-categories.

Table 1

Code Frequencies for the Benefits Perceived by the Participant's Inquiry Practices Regarding the 2016 BC Science Curriculum

Benefits	William	Lola	Jaspreet	James	Cruz	Gary
• **Opportunities for Relevant learning**	5	8	6	9	4	2
• **Increased Teacher and Student Autonomy**	8	12	5	12	4	4
• **Enhanced Student Curiosity**	9	10	5	8	3	5
• **Inquiry-orientated Framework of the BC Science Curriculum**	2	2	2	2	2	2

Opportunities for Relevant Learning

Lola shared that through inquiry-based practices and with the support of the curriculum, "there is no prescribed way" of teaching and learning. An inquiry-based approach allows "the students, or anyone doing an inquiry process […] to see through their eyes" (Lola). Lola described relevant learning as the students finding "the relevance for themselves or they figure out what they want to learn, and they start learning it, and then finding the relevance for that and now all of a sudden it has value to them." Other participants expressed that learning is meaningful and relevant to the students, making connections with their education. Jaspreet mentioned that she prefers an "integrated approach […] so that all of the learning is connected back to the inquiry." This approach allows "the students to develop a more meaningful and more fluid understanding and have enduring understandings that last beyond the single semester they do the study" (Jaspreet). James shared that students have more authentic experiences through an inquiry-based approach since discovering their questions and areas of interest. Along with connections to the individual student, Gary expressed that the "students develop a question [and]

something related to the community." Students and teachers "should get people who are in the community and area involved" (Gary).

Increased Teacher and Student Autonomy

All educators in the research said that the 2016 BC science curriculum allows teachers and students to be autonomous. They believe that students can have greater autonomy with the new curriculum to explore areas of personal interest. Student autonomy is possible because the current curriculum "gives teachers that flexibility" (James). Autonomy allows teachers to "take more time whenever [they] want, and less time on another topic if the students have that inquiry and if they're getting a bit passionate about it" (James). Similarly, Cruz said that the part he likes about the curriculum is the space it allows for greater autonomy for both students and teachers. The reduction of the content requirements creates "more time and space and [does] not feel pressured to have the students prepare for a big content exam" (Cruz). By removing the provincial exams and implementing the current curriculum, educators felt greater autonomy within their practice. William described autonomy as the curriculum allowing "the flexibility and freedom and to encourage you to put your tests and textbooks away and use the tool, which is the subject area to accomplish the curricular competencies." Consequently, the curriculum allows for "student autonomy and agency in their learning" to avoid getting "carbon copies of the same stuff" (William). Educators felt that the autonomy with their inquiry-based practice allows students to be autonomous with their learning.

Enhanced Student Curiosity

All participants felt that an inquiry-based approach enhances curiosity. The reduction of the content in the science curriculum allowed for more space and time for students to delve deeper into their learning. James shared that the curriculum allowed him to focus on “the process

of learning… where the first element from kindergarten up to grade 12 is displaying curiosity." William fostered this learning by having projects that have real-world "prompt questions" to allow them to "follow threads of curiosity." Instead of William telling the students "what they must learn," he believed that with the current curriculum and inquiry-based teaching, students could "explore and try to understand the world, leading to better understanding" driven by curiosity. Lola explained that one of her many inquiry-based learning opportunities created "excitement and wanting to wonder" among students. After this experience, the students could "create any question they wanted to investigate" (Lola).

Inquiry-orientated Framework of the BC Science Curriculum

Throughout the interviews, the participants shared that the inquiry-orientated framework of the redesigned science curriculum is beneficial to their inquiry-based practice. James stated that he does not "see the current curriculum as an impediment to inquiry-based learning." Instead, he thinks "it fits well with getting the students to ask their questions," which focuses on an inquiry-based practice. William explained that the current BC science curriculum is "designed intentionally" to support inquiry-based teaching. Lola supported the idea of having "big ideas that you can focus on because you can [teach] main themes." The implementation of the current curriculum resulted in the provincial science exams being removed. The educators in this research study supported this move by the Ministry of Education because they felt that standardized testing hindered their inquiry-based practice. With all these changes, Lola expressed that "it's not the curriculum that holds [her] back because now they leave it so open, and you can release that control for yourself."

Challenges

Although the participants said that they do not experience challenges within the current BC science curriculum, they shared additional factors that challenge their inquiry-based practice. Two sub-categories that emerged from the participant's responses were lack of professional resources and support and systemic barriers to inquiry-based teaching. Data Table 2 below shows the frequencies of how many times the participant mentioned the codes for the sub-categories.

Table 2

Code Frequencies for the Challenges Perceived by the Participant's Inquiry Practices Regarding the 2016 BC Science Curriculum

Challenges	William	Lola	Jaspreet	James	Cruz	Gary
• **Lack of Professional Resources and Support**	5	11	3	3	5	6
• **Systemic Barriers to Inquiry-Based Teaching**	13	11	13	4	3	2

Lack of Professional Resources and Support

All the participants in the study referenced a lack of support to be an external factor that has negatively affected their inquiry-based practice. Lola said she knew 15 years ago "that there needs to be a drastic shift" from the traditional teaching method towards an inquiry-based approach. When Lola recognized a need for change with her practices, she recalls there being no support "in the province, there was nothing in the district, [and] there was nothing in the area that was providing [them] with answers." Although the 2016 BC curriculum presents an inquiry-based approach, which these participants appreciate, there are still limited resources and supports to assist educators with this change (Gary). Gary stated that "teachers need more Pro-D for inquiry" and "more resources." As Cruz has shifted his practice to using the 2016 BC science

curriculum, he stated that he "would like more examples or exemplars of how to build [the] curricular competency skills" embedded into his inquiry-based teaching. William explained his frustrations with the educational system in BC, saying he believes that he has "done all that [he] can do" in his inquiry-based practice and asking for further support. William shared that he has addressed concerns directly through a "letter to the Minister of Education and the Deputy Minister of Education"; however, he has seen little to no change with how the current system operates.

Systemic Barriers to Inquiry-Based Teaching

The study participants also talked about specific systemic barriers that hinder teachers' ability to implement the new BC science curriculum through inquiry-based practices. The barriers the participants identified are related to assessment and reporting, teacher mindsets, and expectations for post-secondary.

Assessment and Reporting. In an ideal world, Jaspreet explained that inquiry-based learning is a way for the students to "remain curious and continue to pursue" their interests. Since the Ministry of Education is "looking for a number to rank" the students, Jaspreet stated that it "takes away from the learning process [and] stops their creativity." James explained that he implements graded assessments into his practice because he "needs to put marks in." Gary experienced time constraints to implement more inquiry-based learning opportunities because of "a test at the end of the course that [the students] have to be ready for, and it's a content-heavy course." Since Gary is an AP science educator, there are international standardized tests that his students have to write at the end of the course. He has limited time to fully explore the course with an inquisitive approach based on his teaching position.

Lola believes that the "number and letter grade on the report card is killing the new curriculum." The assessment and grading system within the current educational system is also perceived as a challenge for Jaspreet since "[teachers] have to come up with a number in a grade and a product at the end." Removing the number on the report cards would allow educators to believe content is not the focus and understand "that it's not the end-all, be-all" (Jaspreet). William said he "can't imagine a mechanism that would actually be able to measure success in [his] class compared to success in another person's class." William asked, "What is the purpose? What is the value in having another 200 students who can get 70 to 80% on that final exam in the world? Why would you want to perpetuate that?" Jaspreet also questioned the purpose of grades because "it makes no sense, especially considering the amount of control that [she], as a teacher, has over those numbers." Since she controls the tests, rubric, and "then scoring the work," it is biased and limits the curiosity and inquiry with learning. In Jaspreet's words, the current grading approach:

> Stops [students'] curiosity, they start to think that they should just add up all the activities and the assessments and divide by the total to get some number that will validate them when, in fact, they should be validated because they have great questions and good curiosity which is ultimately what [Jaspreet] sees as the driving factor of science.

William feels strongly that if the Ministry of Education "*really* cared, if they *really* wanted [children] to learn and if they *really* wanted everybody to implement the curriculum the way it's intended to be, they would abolish grades." Likewise, Gary, Lola, Jaspreet, and James shared during their interviews that they believe the whole system will remain flawed until grades are gone.

Teacher Mindsets. The participants described the challenge they face working in a department with different mindsets. Jaspreet shared that she was questioned by a colleague, asking if she covered all the curriculum through her inquiry-based approach. She views the curriculum and her practice differently than her colleagues. She does not "evaluate and ensure that students' skills in each of those fields of science are assessed in the same rigour as it had been done in the past," and if it does not relate "back to the overall inquiry, or the student's research subject of interest then she does not force them to understand." Jaspreet believes that her colleagues do not understand her practice or the 2016 BC curriculum to the same extent. Lola said that "the challenges [that she] faces are not the curriculum; however, the educators around [her] can be." She felt that more experienced educators do not think that the system needs to be changed. By having "a closed mindset," the educators are not "current in the new strategies or new practices" required for the current curriculum (Lola). James recalled a similar experience because he found it "interesting to see how many teachers hated the new curriculum when it came in" because of the inquiry-based approach. The educators who expressed their feelings towards the implementation of the 2016 curriculum were "focused on content," and "some of them were a little grumpy when the new curriculum came in because they weren't [teaching] properly" (James).

The notion of vulnerability also surfaced within the discussions related to teacher mindsets regarding inquiry-based learning. Lola said that the process of becoming an inquiry-based teacher means that "you second guess yourself, but if you know what's right for the students and you know what's right for learning, you need to push through that." Lola indicated that even though she was scared, she knew that she had "to be vulnerable" because it was the right thing for her practice and student learning. She added that this was a pivotal moment for her

in her teaching journey. The process may look as not “having the answers” and knowing that is acceptable (Lola). Jaspreet stated that “teaching from an inquiry mindset requires a lot of bravery.” The “teacher has to be courageous and be willing to make mistakes.” Teachers should not feel afraid to try something new (Cruz). The current curriculum encourages inquiry-based practices and focused on curricular competencies, which means that some educators have had to change their approach to meet the new standards.

Participants in the study also alluded to the requirement for teachers to ‘unlearn’ previously held views about teaching and learning. Jaspreet shared that teachers' mindsets play an essential role in implementing inquiry because teachers need to be “willing to accept that learners who may have seemed unsuccessful in the past” may be able to thrive with a new or different approach. Jaspreet explained that inquiry-based teaching “is not for the faint of heart and requires a considerable amount of paradigm shift from the traditional classroom style.” William mentioned that inquiry “requires an intentional exhausting effort not to do what you have been shown to do.” William explained unlearning as “model breaking” which helps teachers develop and grow with their practice. Model breaking is using your judgement about the world to “find out that those judgements are wrong, and you deconstruct your previous model and then build a new one” (William). Lola beautifully articulated that aligning practices with purpose will only work by “tearing everything down and starting over to really have this work.”

Expectations for Post-Secondary. Another systemic challenge that the participants highlighted was a concern for preparing students who are applying to universities. Cruz posed the question “about going full inquiry and the [students] not having a solid foundation of information to be successful in post-secondary”. William stated that “the critics will point to you and say, well, they’re going to fail their exams in university” when taught through an inquiry-

based approach. Lola indicated that “the universities are killing the new curriculum because they require a grade for university.” Universities should be able to figure out an alternative way of accepting students into universities, and “it’s not the public school’s problem to accommodate university grades” (Lola). Jaspreet said that final grades hinder inquiry-based teaching because of the expectation to cover all the content, produce a final product, and then ranking the learning. The expectations felt by the participants limit the relevant learning opportunities and reduce the time to focus on inquiry-based learning.

Discussion

The purpose of this research study was to explore the question, "What benefits and challenges, presented in the 2016 BC science curriculum, are perceived by secondary science teachers experienced in science inquiry?" The data analysis revealed two main themes that reflect the perceived benefits and challenges of the redesigned science curriculum. The participants identified the benefits of the 2016 BC science curriculum as relevant learning, increased student and teacher autonomy, enhanced student curiosity, and the inquiry-orientated framework of the BC science curriculum redesign. Challenges that emerged from the data were connected to a lack of professional resources and supports for teachers and systemic barriers to inquiry-based teaching such as assessment and reporting, teacher mindsets, and expectations for post-secondary. This section will explore the interpretations of these findings, the study limitations, and several recommendations to help teachers implement the redesigned BC Science curriculum to support their inquiry-based practices.

Teachers’ Understanding of Inquiry

All the participants expressed their understanding of inquiry-based teaching. Their definitions are consistent with research by Sun et al. (2015) who suggest that a constructivist learning method better serves learners to actively construct their learning. The teachers in the study valued the opportunity for ‘hands-on’ and ‘minds-on’ learning through their inquiry-based approaches. These results reflect the idea that teaching through inquiry helps students engage more with their learning and develop nature of science (NOS) understandings (Abd-El-Khalick, 2013). The participants in this study appear to have a deep understanding of the importance and significance of inquiry-based teaching in science.

Benefits of the Redesigned BC Science Curriculum

To my initial surprise, the participants who self-identify as inquiry-based teachers supported the 2016 BC curriculum redesign. While this finding was different from my personal experiences with colleagues, administrators, and students who had expressed a negative attitude towards the redesigned BC curriculum, it aligns with the 2016 feedback report completed by the BCTF, which found that educators in the province were generally positive about the inquiry approaches that support the curriculum (BCTF, 2016). The BCTF report revealed that the redesigned BC science curriculum creates opportunities for relevant learning, increases student and teacher autonomy, enhances students' curiosity, and provides an inquiry-orientated framework. The most compelling explanation of these findings is that the participants support the 2016 BC curriculum because their inquiry-based practice aligns with the inquiry focus of the curriculum.

Based on the participants' perceptions, there are opportunities for relevant learning presented in the BC science curriculum. Diverse learning opportunities are created through inquiry-based learning because of the emphasis on different experiences, cultures, backgrounds,

and ways of thinking (Summerlee, 2018). My findings support the idea that diverse learning experiences through inquiry-based learning fosters more opportunities for relevant learning for the students. The BCTF (2016) research argues that teachers do not support the changes in the BC curriculum because they are still trying to understand how to create "personalization" of learning (p.9). To my surprise, this study found creating personalization of learning to be a strength. The participants in this study believe that student-centered learning is essential because it allows the learners to construct their questions based on their experiences, passions, and interests. The results strongly imply that inquiry-based teachers can facilitate opportunities for relevant learning for students by allowing them to explore areas of interest and different passions through inquiry-based learning. This explanation aligns with Isik-Ercan's (2020) research that found students can build their understanding of scientific concepts through play and exploration. Teachers can create these relevant learning opportunities for students because, as Lola mentioned in my study, "there is no prescribed way" of teaching and learning with inquiry-based practices and using the BC science curriculum.

This study revealed that a sample of teachers felt that the 2016 BC curriculum increased teacher and student autonomy. They may feel this way due to the flexibility of the curriculum due to reduced content requirements. This rationale is supported by the BC Ministry of Education's (2012) approach to remove "barriers that limit teachers' ability to innovate and personalize learning" (p. 2). With this, teachers have more time and space to explore areas of their own and students' interests. As one participant remarked, the inquiry-based approach and the redesigned curriculum allow for student autonomy and agency. In an inquiry-based approach, students are encouraged and supported to explore areas of passion and interest to become an "active participant in the learning process" (Blessinger & Carfora, 2015, p. 6). Through "voice

and choice," the students have autonomy over their learning (BC Curriculum, 2020a). The findings suggest that the BC science curriculum may provide opportunities for increased teacher and student autonomy within an inquiry-based approach.

The findings revealed that teachers believe an inquiry-based approach using the BC science curriculum enhances student curiosity. The participants see the redesigned curriculum prioritizing student curiosity. An inquiry-based approach that prioritizes fostering curiosity among students appears to align with the design of the BC curriculum. The BC Curriculum (2020b) states that the main features of the science curriculum are inquiry and conceptual learning. Buchanan et al. (2016) explain that curiosity is fostered because the students are actively engaged in the learning process by developing their driving questions in an authentic and situated inquiry where they have ownership of the problem. The findings of this study suggest that when learning is inquiry-focused, student curiosity is enhanced.

The secondary science teachers in this study appear to support the redesigned BC science curriculum because of the inquiry-orientated framework. It is possible that the inquiry focus of the 2016 BC curriculum aligns with their inquiry-based teaching approaches. With a focus on inquiry, teachers can encourage students to ask questions, consider diverse perspectives, recognize and form their beliefs and opinions, and make informed decisions (BC Curriculum, 2020b). Another interpretation is that science concepts align with inquiry-based approaches. William explained that the current BC science curriculum is "designed intentionally" to support inquiry-based teaching. Capps and Crawford (2012) highlight that scientific concepts are supported by inquiry because students can "answer questions and develop explanations and models using logic and critical thinking" (p. 501). The findings highlight the idea that science lends itself to an inquiry-based approach.

Challenges of the Redesigned BC Science Curriculum

I went into this research anticipating that the 2016 BC science curriculum would be a challenge for inquiry-based teaching; however, the study revealed that other challenges were greater impediments to implementing the BC curriculum and inquiry-based practices. The participants identified a lack of professional support and resources and systemic barriers to challenge inquiry-based teaching. The systemic barriers include assessment and reporting, teacher mindsets, and expectations for post-secondary. It would seem that the current curriculum supports the goals of science education; however, educators are still experiencing challenges with the existing policies and structures of the educational system in BC.

The participants expressed a lack of professional support and resources as challenges to inquiry-based teaching and full implementation of the 2016 BC curriculum. These challenges include a lack of professional development opportunities, guidance from the district, and the BC Ministry of Education. These results suggest that there has been insufficient training provided for teachers for the implementation of the 2016 BC curriculum. The research of Kazempour and Amirshokoohi (2014) highlight the importance of effective professional development to support teachers with their inquiry-based approaches and resources that outline diverse teaching practices. Additionally, the BCTF (2016) research reports that teachers had inadequate resources to support the curriculum change and fund resources. The new ideas in the BC curriculum advance inquiry-based learning pedagogies and a competency-based instructional focus. It appears these ideas were introduced before providing sufficient information and training about the new concepts to teachers and leaders. I agree with Timperley (2008), who encourages leaders to facilitate professional learning and development to ensure teachers understand the new learnings in practice.

In a study completed by the BCTF (2016), their findings state a misalignment of assessment and reporting to the current curriculum. The findings of this study highlight that this misalignment occurs because the purpose of the BC curriculum does not align with standard assessments and provincial reporting practices for report cards. The curriculum's focus is on competency-based outcomes; however, curriculum documents do not give direction on assessing competencies (BCTF, 2016). For example, educators struggle to assess competencies such as empathy or translate collaborative learning into a mark (BCTF, 2016). Interestingly, the 2016 BC curriculum was implemented into the existing educational system in BC without revisions to the assessment and reporting methods or policies. The School Act in BC requires a letter grade to be included on report cards for secondary students (BC Ministry of Education, 2021). The results of this study suggest that there is a need for better alignment of provincial curriculum and reporting policies.

The participants in this study revealed that teachers' mindsets may be a challenge for full implementation of inquiry-based practices in science courses. This finding may explain the idea that there are deep-rooted traditions and expectations for teaching practices within the educational system in BC. Some educators have traditional beliefs about teaching science (Letina 2019; Tsai, 2002). Another interpretation of these findings could be that educators are not aware of the strengths of inquiry-based learning for students. It appears that inadequate knowledge of inquiry-based teaching and the 2016 BC curriculum could result in negative perceptions of this approach to teaching among science educators. These findings suggest the need for ensuring a safe space for educators to learn about and implement inquiry-based practices in science courses. The safe space would allow courageous educators to embrace their inquiry-based practices.

The pressure to align inquiry-based practices with post-secondary expectations was a significant finding in this study. Science teachers may fear that students will not be equipped for rigorous and traditional learning in universities since post-secondary institutions have a different learning focus compared to the K-12 public education system. The findings also reveal how the admission process for post-secondary may hinder teachers' inquiry-based practices. Universities require a letter grade for admission. It appears that some educators feel pressure to comply with the universities because of how they operate, instead of having complete flexibility over their practice and assessment within an inquiry-based model of instruction. I wonder how differently inquiry-based practices would be implemented without the pressure of these external factors.

Study Limitations

There are limiting factors associated with this research study. First, given the short time frame for data collection (January to early February 2021), a small sample size had to be considered, which did not allow for a cross-section of the BC teaching population. In addition, this study was limited to data from teachers in one school district. Future research with a more extensive and diverse sample group of participants would provide further insights into secondary teachers' perceptions of the benefits and challenges to inquiry-based teaching within the redesigned BC science curriculum.

Recommendations

The findings from this study suggest that further supports are needed for the implementation of the 2016 BC science curriculum based on inquiry-based teaching practices. Resources and supports for inquiry-based teaching, a reconsideration of assessment and reporting, and starting a critical conversation about the systemic barriers are recommended actions.

Teachers in this study expressed their concern for the lack of professional resources and support to assist with the early transition to inquiry-based learning. I recommend the development of resources that provide examples of inquiry-based approaches based on the curricular competencies presented in the 2016 BC curriculum. I would also suggest providing these examples in professional development opportunities for teachers to fully understand inquiry-based approaches within the context of the redesigned curriculum. Timperley's (2008) research suggests that leaders should facilitate professional learning and development for leaders. I encourage all leaders in the schools and districts in BC to facilitate and engage in professional development to ensure that teachers understand inquiry-based approaches and curriculum changes and that they have access to abundant professional learning opportunities.

The findings revealed a need for the reconsideration of assessment and reporting to better align with the goals of the 2016 BC curriculum. I recommend using a variety of assessments that "go beyond standardized testing" (Timperley, 2008, p. 13) to be responsive to the learning needs of *all* students. I recommend exit interviews in addition to final exams. Exit interviews would allow students to demonstrate personalized learning in science concepts. Another alternative to standardized testing is using portfolios to demonstrate student learning. Portfolios allow the students to collect evidence of their learning that they found meaningful. I further recommend moving towards gradeless reporting because many of the competencies cannot accurately reflect a percentage. Gradeless reporting removes the percentage and letter grade throughout the students' learning journey and focuses on written comments (either a self-reflection from the student or a teacher comment) that illustrate the students' development of the competencies. To realize revamped assessment and reporting practices in the K-12 system, post-secondary entrance requirements would have to align as well.

Lastly, the findings of this study highlight many systemic barriers that hinder educators with their inquiry-based practice and the urgent need to start a critical conversation about improving the alignment of current educational policies and systems in BC with the redesigned 2016 BC curriculum. I plan to initiate a professional learning community at my current school to critically analyze the challenges of the educators' inquiry-based practice regarding the BC curriculum. This action will allow me to use the leadership and mentorship skills I have developed in my graduate studies and, through this research, to understand the perceived benefits and challenges of the BC curriculum in supporting educators with their inquiry-based practice. Eventually, I hope to include other educators from all over BC in this conversation and create a safe space where other educators, administrators, students, and staff can collaborate about challenges, issues, or concerns regarding their inquiry-based teaching and/or learning process. As a leader, I will approach this conversation through a socially just and equitable lens - gathering insights from diverse perspectives across the province to understand the challenges and opportunities for inquiry-based teaching and learning in BC.

This study enhanced my understanding of the relationship between inquiry-based practices and the 2016 BC sciences curriculum. This research also significantly contributed to my vision and development as an educator and as a leader. I am committed to supporting teachers in providing students with inquiry-based learning opportunities to discover, engage, and transform their thinking.

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Appendix A

HREB Ethics Approval

Human Research Ethics Board - Certificate of Ethical Approval

HREB Protocol No: 100568
Principal Investigator: Ms. Sandy Gill
Team Members: Ms. Sandy Gill (Principal Investigator)
Mr. Kirk Savage (Supervisor)
Dr. Sheryl MacMath (Course Instructor)

Title: Science teachers reflect on their inquiry-based practice
Department: Faculty of Professional Studies\Teacher Education

Effective: December 18, 2020
Expiry: December 17, 2021

The Human Research Ethics Board (HREB) has reviewed and approved the ethics of the above research. The HREB is constituted and operated in accordance with the requirements of the UFV Policy on Human Research Ethics and the current Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2).

The approval is subject to the following conditions:
1. Approval is granted only for the research and purposes described in the application.
2. Approval is for one year. A Request for Renewal must be submitted 2-3 weeks before the above expiry date.
3. Modifications to the approved research must be submitted as an Amendment to be reviewed and approved by the HREB before the changes can be implemented. If the changes are substantial, a new request for approval must be sought. *An exception can be made where the change is necessary to eliminate an immediate risk to participant(s) (TPCS2 Article 6.15). Such changes may be implemented but must be reported to the HREB within 5 business days.
4. If an adverse incident occurs, an Adverse Incident Event form must be completed and submitted.
5. During the project period, the HREB must be notified of any issues that may have ethical implications.
***NEW** 6. A Final Report Event Form must be submitted to the HREB when the research is complete or terminated.

Appendix B

Interview Questions: The interview questions (along with the sub-questions) used for the interviews.

1. What does inquiry-based learning mean to you?
    - How do you define inquiry-based learning?
2. What does it mean to be an inquiry-based science teacher?
    - How often are inquiry-based lessons implemented?
    - How long have you been teaching through inquiry?
3. Tell me what science inquiry looks like in your classroom.
    - How do your science lessons support inquiry-based learning?
    - Describe what one of these lessons may look like in your classroom.
    - What are some experiences that stand out for you?
    - Why do you choose inquiry-based teaching?
4. What strengths does the current BC science curriculum provide for your inquiry-based practice?
    - Please provide examples.
5. What challenges do you face for implementing inquiry-based learning using the current BC science curriculum?
    - How do you overcome them?
6. What specific recommendations would help you further support your inquiry-based teaching practices?
7. Is there anything else you would like to add?